

## DATA MODEMS

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#### 1. GENERAL

1.1 This section provides REA borrowers, consulting engineers and other interested parties with information for use in the design and construction of REA borrower's telephone systems. It discusses the classifications, types, and uses of data modems, data interface considerations, and applications of data systems to rural telephone systems. This section treats primarily the situation where a customer leases data equipment and services from the telephone company. It does not apply specifically to data equipment and services needed by the telephone company for its own operation. The transmission aspects of data are dealt with in this section only to the extent necessary to clarify interface and terminal functions. Data transmission per se will be covered in a separate TE & CM section. A summary of terminology and definitions commonly used in data systems is covered in Appendix I.

1.2 To date, not many loans have included data services. A large potential demand for data services exists in rural areas but aggressive

action by the telephone company is needed to develop this potential into firm orders for data service. Borrowers and their engineers must know and understand the customer's needs and must have sufficiently detailed knowledge of available data equipment and applications to adequately meet those needs. If the borrowers and their engineers are unable to meet this demand, subscribers will turn to other sources, thus causing a loss of revenue for the telephone company.

1.3 This section is concerned primarily with the equipment that forms the interface between a customer owned business machine and the communication channel. This interface equipment is called a data modem. The principal function of such equipment is to take the output of a business machine such as a computer, convert it into a form suitable for transmission over a communication channel, and reconvert it to business machine form at the distant end. Because the desirability of using ordinary voice frequency loop plant as a circuit facility for data transmission is frequently an overriding consideration, most applications are expected to require slow and medium speed data sets.

1.4 A wide variety of data modems and terminal equipment is being marketed in increasing quantities. When associated with a data business machine and a data modem, every ordinary telephone station installation could become a point of entry for data to a communications facility, whether it be a public switched network line or a leased private line. The simplest form of data modem is the pushbutton telephone set which can be used to access a computer, provide input data to the computer, and (if the computer terminal is properly equipped) receive data output from the computer.

1.5 "Data Phone"\*service is a tariffed service offering of the Bell System for the transmission of data over the switched telephone (DDD) network. This service, like regular voice service is offered on a monthly rental basis, with the circuit facilities and all necessary equipment (except the customer owned business machines) being furnished and maintained by the Bell System operating telephone company. "Data Phone"\*service has grown rapidly since its introduction in 1958 because it is a versatile and economical means of transmitting business data from point to point.

1.6 It is important that the manager study the immediate and probable future data system requirements of his customers. He must also become familiar with modem capabilities and features, and the required characteristics of the telephone loop and trunk circuits. Detailed specific information on particular makes and types of modems is readily available from the equipment manufacturer. Circuit facilities commonly

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\*AT&T Registered Service Mark and Trademark

used for data communications include: the public switched network; dedicated leased lines without conditioning; and dedicated conditioned leased lines. Two wire lines are usually required; however, four-wire circuits may be required in some instances.

1.61 Conditioned lines are point-to-point circuits which have specified transmission characteristics quoted in the applicable tariffs. The detailed specifications for Bell System private leased lines can be found in the Bell System Technical Reference, Publication 41004 entitled "Transmission Specifications for Voice Grade Private Line Data Channels." This document and other "Bell System Technical References" can be obtained for \$1.50 each from:

American Telephone and Telegraph Co.  
Supervisor - Information Distribution Center  
Room 208  
195 Broadway  
New York, N. Y. 10007

1.611 Publication 41004 gives the specific characteristics required for data transmission channels for the various data sets. Attenuation, bandwidth, noise, phase jitter, envelope delay distortion, echo, impedance, and power levels are specified. If the channels in question do not meet the requirements, conditioning must be applied to correct them. Abbreviated specifications for several different types of conditioning are shown in Table 1.

1.612 Because of the broad, flat, pass band and low delay distortion of D66 loaded loops and trunks it is probable that many cable circuits in REA borrowers' systems can be used for low and medium speed data transmission without conditioning. Where a number of data channels are needed between two points carrier channels are preferred if they meet the specified data transmission requirements. These characteristics of carrier channels can be obtained from the carrier manufacturers.

1.613 Neither cable pairs nor carrier channels should be used for data transmission without first measuring attenuation, delay distortion, and impulse noise. A circuit facility which is known to be a good voice channel may not be satisfactory for data transmission because delay distortion, impulse noise, and phase jitter, which are relatively unimportant in voice communications, may make a good voice channel totally unsatisfactory as a data channel.

1.62 When planning a data system, the factors of economics, expandability, redundancy, reliability, and service must be considered as well as the technical characteristics of the equipment. Under economics, factors such as the cost of leasing from the telephone company versus purchasing of equipment by the customer are important. Modems, like most of the other equipment required to develop a data system, can generally

be either purchased or leased from the manufacturers or suppliers. It is important to have a system that can be economically modified, either expanded or reduced, to meet the customer's changing needs. The need for redundancy varies greatly depending on a number of factors. For example, if very important "real time" data is involved, complete redundancy and substantially errorless data transmission are important. In other situations continuous operation 24 hours per day 7 days per week may be important. Where an occasional system "down-time" can be tolerated, and where intermittent rather than continuous transmission is involved, less reliable, less costly equipment can be used. However, if poorer quality equipment is used, error rates may become unacceptable, and retransmission costs may become excessive.

## 2. INTERFACES

2.1 The rapid growth in data communications and technology has been aided and guided by standards, principally issued by the Electronics Industries Association (E.I.A.). This Association has issued a number of important standards on interface considerations which enhance compatibility among different makes and types of equipment. Standard RS-232-C, "Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange" was issued in August 1969. It specifies the functional and electrical characteristics of all interchange circuits between the data terminal equipment and the data communications equipment. It also specifies that the mechanical interface between the business machine and data set be a multi-pin plug-in connector. Certain pins have specifically designated functions; such as, Pin 1 is "Protective Ground;" Pin 2 is "Transmitted Data;" Pin 3 is "Received Data;" and so forth. This standard is now well recognized and followed by most suppliers for speeds up to about 20,000 bits per second (bps).

2.2 The line sides of data modems interface with telephone circuits. For data speeds up to 2400 bps on either a point-to-point private line or on the public switched network, regular voice frequency loop and trunk plant circuit facilities are generally adequate.

2.3 For data speeds in excess of 2400 bps, data modems usually must work into conditioned lines. However this situation is changing rapidly as new data modems are developed. Some data modems are available today which operate on unconditioned lines at speeds of 4800 bps or higher.

## 3. CODES

3.1 The business machines (terminals), at each end of a data communication circuit, "talk" to each other by means of a machine language comprised of a specific code transmitted in accordance with a specific format and a specific rate of speed. The basis of all effective data trans-

mission is the standardization of codes. The first data transmission code, Morse Code, used dots and dashes for characters. The most common business equipment code in use during the early sixties was the Baudot code, as used by teleprinters. The Baudot code has five bits per character and is usually encoded as a paper tape having five rows or "levels." With the introduction of computer processing, codes have been developed which use a greater number of bits per character. Examples of these codes are "Fieldata," six bits per character; IBM "Teleprocessing," eight bits per character; and the American Standard Code for Information Interchange (ASCII), basically seven bits per character. When transmitting ASCII code, an eighth bit is used as a check, or parity bit, for error correction purposes. This eighth bit is not actually part of the basic code structure. There are a total of 128 specified combinations covering the alphabet (both upper and lower case), the ten numerals, and 66 special symbols. The ASCII code card is illustrated in Figure 1, and can be obtained from EIA or from computer and data set manufacturers.

3.2 The Baudot and ASCII codes are basically designed for transmission of the English alphabet. Other codes are used for special purposes, such as the "Extended Binary Coded Decimal Interchange Code." (EBCDIC). Here, the numbers from 00 to 99 can be used to identify letters, numbers, and symbols. The format characteristics of the code will vary depending upon a particular terminal equipment, purpose, and design. A specific code format is required for error control and is also required for compatible operation. However, code compatibility alone does not insure compatible operation. Supervisory ("handshake") signals, speed, and mode of operation must also be compatible. It is particularly important to check all aspects of compatibility when a system is being designed which involves equipment from different manufacturers. It is anticipated that this situation will occur frequently because there will be many cases where one end of a data circuit will be furnished by a Borrower and the other end will be furnished by the Bell System or some other telephone company.

#### 4. DATA MODEMS

4.1 The term "Modem" is actually a contraction of the two functions to be performed, i.e., modulating and demodulating. The terms "data set" or "data subset" are also used to identify a modem. Data modems can be classified as analog or digital depending on the nature of the customer's signal.

4.2 A digital data modem is a device which accepts the d.c. pulse output from a computer, teletype, or other business machine equipment and converts this output to an audio signal or frequency which is more suitable for transmission over voice grade lines or other communication facilities. At the receiving end, these signals are then reconverted to their original dc pulse state, making the data once again usable for terminal equipment.

Digital data modems usually are classified by speed range. Low speed is up to about 300 bps. Medium speed has been from 300 to 2400 bps but recent development of adaptive automatic equalizers have made it possible to operate this medium speed equipment up to 9600 bps under some conditions on paired cable or carrier facilities. The term "high speed" data is usually applied to bit rates which require broad band transmission facilities.

4.3 Analog data modems accept data in the form of a continuously variable signal and processes the signal for transmission over the telephone circuit. Analog data are usually represented by variables such as voltage, resistance, phase rotation, etc. Some uses of analog modems are for transmitting facsimile, certain types of medical data, temperatures, and pressures.

4.4 There are four basic types of modem designs, classified with respect to their associated method of modulating the signal presented to the telephone line.

1. Amplitude Modulation (AM)
2. Frequency Modulation (FM)
3. Phase Modulation (PM)
4. Pulse Code Modulation (PCM)

A description of these follows:

4.41 The AM Modem transmits a constant frequency to the telephone line. Amplitude varies depending upon the value of the dc binary information. For example, a dc "1" level from the business machine will be converted by the modem to a full amplitude tone while a dc "0" level will be converted to a lower amplitude tone. AM is generally used for low speed data transmission (up to 300 bps), and is the least complex to design and manufacture. However, AM modems tend to react to burst or impulse noise which varies the amplitude and energy level of the transmitted signal. For example, impulse noise coincident with an "0" level can raise the amplitude so that the demodulator interprets the received signal as a "1" level.

4.42 The FM modem transmits a constant level of amplitude to the telephone line, but indicates a "1" by one frequency and a "0" by a different frequency. For example, a dc "1" level will be frequency #1, while a dc "0" level will be frequency #2. FM is generally used for medium speed data transmission in the 300 to 1800 bps range and is more complex to manufacture than AM modems. The FM modem has a higher immunity to impulse noise than the AM modem.

4.43 The PM modem transmits a constant amplitude and frequency to the telephone line; however, the phase changes depend upon the value of the dc binary information. For example, a dc "1" level could be phase  $0^{\circ}$  while a dc "0" level could be shifted in phase  $180^{\circ}$ , or some other value, from the previous phase. PM is generally used for data transmission in the 2000 bps to 4800 bps range, and is quite complex in design and manufacture. PM modems have excellent noise immunity characteristics, since they use constant amplitude and frequency, and generally higher information handling ability

than AM or FM systems, but are more susceptible to impaired performance from phase jitter.

4.44 Pulse Code Modulation (PCM) transmission is a type of transmission that requires a much greater bandwidth than voice. Bandwidths exceeding the bandwidth of a single voice channel (about 4 kHz) are called wideband modems. Wideband modems are not true modems since they do not contain a modulator or demodulator, but they do condition a digital signal for transmission over the telephone network.

4.441 An important advantage of PCM is that once all the signals are in digital form (voice, telegraph, television, facsimile, data, and others) the signals can be time division multiplexed and carried over the same transmission medium without interfering with each other. The PCM systems are expected to have a major impact on wideband data transmission. For example, the PCM-T1 digital transmission system has a line rate of 1.544 megabits per second. Ninety percent of this spectrum width can be used for data transmission. By the use of various modems, eight 50 kb/s channels, two 250 kb/s channels, or one 500 kb/s channel can be accommodated on a single T1 carrier system. With special arrangements, the full bandwidth could be used. Newer PCM-T2 and T4 digital transmission systems will operate at 6.3 and 281 megabits per second respectively.

4.5 While standardized codes and formats are important to the intelligibility of a transmitted signal, compatible timing is equally important. Modems are classified with respect to method of timing as: (a) asynchronous, or (b) synchronous.

4.51 Information may be transmitted in a bit-serial asynchronous mode, (with start and stop bits). When asynchronous transmission is used, a mark condition is maintained on the line during any idle state. When a character is to be transmitted, a space condition is sent as the first bit to indicate the start of a character. This is followed by an appropriate mark or space condition for each data bit of the character. The last bit of the character is followed by a stop pulse which is always marking and which may be equal to or longer than the bit length. The line remains in a mark condition until the next character is ready (See Figure 2). These modems operate very reliably within their stated limits and are generally used at transmission rates up to 1800 bps.

4.52 Information may be transmitted in the synchronous mode. This technique transmits bits at a constant rate as opposed to asynchronous transmission. When synchronous transmission is used, the transmitting terminal and the receiving terminal are timed from a synchronized clock and the bit code is transmitted without start or stop codes. The start of the message is a series of prescribed synchronizing code characters, called SYNC code. The receiving modem has the capability of establishing the timing synchronization of its clock with that of the transmit modem by sampling the received bits. The receiving terminal interprets the first space bit transmitted as the start of the character signal and samples each of the following bits at a rate dictated by the receiver's clock. As the bits are sampled,



the mark or space condition is transferred from the line and stored within the receiving terminal. Characters transmitted via this bit stream have the last data bit of one character immediately followed by the first bit of the next succeeding character. The receiving terminal has the necessary logic required to count up the bits in a character and separate individual characters from the incoming bit stream. Synchronous modems are available with bit rates of 1200 bps and higher. These modems operate only at specified speeds. A higher transmission efficiency can be achieved since the only noninformation parts of the transmission are the parity bits and control codes, such as the SYNC code.

4.6 Some modems also contain line equalizers or line conditioners as part of their design. The equalizers are intended to complement, not replace, common carrier provided line conditioning. These modem equalizers essentially perform the "fine tuning" required for higher transmission speeds. Modem equalizers can be either manual or automatic. With automatic equalization, the receiving modem can sample the delay variations present in a received signal and automatically introduce delay at the appropriate frequencies to insure that all frequencies are received at the same time.

## 5. CLASSIFICATION AND TYPES OF DATA MODEMS

5.01 The Western Electric Company has established equipment series numbers to designate different data speeds and types of data modems. Most of the independent data modem manufacturers have used this same basic designation number series to identify their equivalents of the Western Electric modems. In many instances the same designs are used so that the independent products are completely compatible with the corresponding Western Electric modems. It is, therefore, practicable in many instances for independent equipment to be used on one end of the circuit and Western Electric equipment on the other end.

5.02 Generally modems can also be divided into "family" groups. Each group has basically similar characteristics and is normally assigned a special hundred series code. Numeric codes within each series are applied to data modems to designate specific models. For example, a 101 data modem has low speed, serial transmission techniques; but it differs slightly from other sets in the same series, such as 103 data modem. In addition, a letter suffix such as a 103A or 103F is added to the numeric code to indicate the modifications and variations of a particular modem or in some cases, to differentiate between a transmitter and a receiver. A further breakdown is sometimes provided by including an additional numeric suffix to indicate other options such as 103A1 or 103A2. The choice of a particular data modem will depend on the application for which it is intended. The type and quantity of data to be transmitted, the speed and accuracy desired, and the type of business machines used largely determine the data modem to be used. The Western Electric modem series is as follows.



5.03 The 100 series data modems are generally low speed transmitter-receiver modems. The type of transmission is bit-serial with a bit rate of 0-300 bps, asynchronous on the voice switched network (Direct Distance Dialing, DDD) and Private Line (PL) facilities and 0-150 bps, non-synchronous on teletype facilities. The private line facility may be a line equivalent to a Bell System 2001 or 3002 type conditioned line (paragraph 1.61) depending on the modem model to be used. Modem operation is half-duplex or full-duplex on two wire facilities. These modems are primarily used with teletypewriters and other types of business machines. Data modems used on the DDD network generally use a separate six-button key telephone set or Auxiliary set for alternate voice/data operation. Dialing methods may be either rotary, push-button, rotary with card dialer, or pushbutton with card dialer. Generally, the buttons are labeled DATA, CLEAR/TALK, TEST, (spare), (spare), and AUTO (for automatic answer) although other variations may exist, depending upon the data modem options. A loudspeaker with a volume control knob may be used for monitoring call progress tones when calls are originated in the data mode. The 100 series data modems may also be used in multiple data modem installations.

5.04 The 200 series data modems are generally medium speed transmit and/or receive modems. The type of transmission is bit-serial. Bit rates may be up to 3600 bits per second on DDD and up to 7200 bits per second on private line facilities using synchronous and non-synchronous modes, depending on the modem model used. The private line facility may be a line equivalent to a Bell System 2001 or 3002 type line with no conditioning or with C1 or C2 conditioning (see paragraph 1.61). Modem operation is half duplex on two wire or full duplex on four wire facilities. These modems are primarily used with various types of business machines. Each data modem used on the DDD network generally uses a separate six-button telephone set or Data Auxiliary set with button designations and a dial. A loudspeaker similar to that described under the 100 series of Data Modems is optional. Synchronous modems require a clock or timing signal either generated internally by the modem or provided by the data processing equipment. This clock is used to sample the d.c. signal and activate the modulator. At the processing location the clock sends a signal to the data processing equipment when each newly received bit has been demodulated.

5.05 The 300 series data modems are generally higher speed transmit-receive modems. The type of transmission is bit-serial. Bit rates available, at present, include 19,200, 40,800, 50,000, 230,400, and 460,800 bps synchronous on private line facilities. The private line facility generally may be a line equivalent to a Bell System 5700 or 8800 type. Modem operation is half duplex on two wire and full duplex on four wire facilities. These modems are primarily used with high speed business machines. These data modems normally require a separate Data Auxiliary set containing six buttons and a rotary or push-button dial similar to that described under the 100 series of data modems. The 300 series also includes wideband data modems for use in the transmission of serial binary synchronous or nonsynchronous

high speed data over half group, group, or supergroup carrier facilities. Wideband data applications require a high degree of custom engineering and the installation of special equipment for higher speeds.

5.06 The 400 series data modems are generally low and medium speed separate transmit and receive modems. The type of transmission is parallel by bit, serial by character; that is, the characters are sent sequentially and the bits within the characters are dealt with simultaneously (not one after another). Bit rates available, at present, include 40, 90, 130, and 600 bps nonsynchronous on DDD and private line facilities. The private line facility generally may be a line equivalent to a Bell System 2001 or Type 3002, with or without C1 conditioning. Modem operation is half duplex on two wire and full duplex on four wire. These modems are primarily used on low speed nonsynchronous data collection devices, alarm reporting terminal equipment, and telemetry devices. The telephone handset, buttons, and dial may be integrated into the data set housing or may be in a separate Data Auxiliary set.

5.07 The 500 series data modems are wideband modems for high speed parallel applications with synchronous or nonsynchronous operation. Western Electric does not have any 500 series equipment available at the present time, but 500 series modems are available from one or more independent suppliers.

5.08 The 600 series data modems are generally intended for analog transmission on DDD and private line facilities. The private line facility may be a line equivalent to a Bell System 2001 or 3002 with no conditioning. Modem operation is half duplex on two wire operation. These modems may be used for reception and transmission of handwriting, facsimile, and of medical diagnostic data, such as electrocardiograms. Data sets in this series that are intended for fixed installation usually have a complete telephone set integrated into the data set housing. Portable battery operated data sets for transmission of medical data are also available in this series for use at the patient's bedside. These modems are acoustically coupled to the telephone line. Acoustically coupled modems are discussed in paragraph 6.

5.09 The 700 series is reserved for wideband analog modems. At the present time there are no modems available in this series.

5.10 The 800 series covers auxiliary units used in conjunction with other data modems and are generally automatic calling units. These units usually contain automatic dialing and control equipment, and are needed when automatic calling is required.

5.11 The 900 series covers interface adapters and test equipment.

5.12 Appendices II and III are reprinted from a copyrighted article entitled "Data Modems '73" by Warren G. Bender in the January 1, 1973, issue of the magazine "Telephone Engineer and Management." The information in these

appendices was obtained from a survey by TE & M of every known U. S. supplier of data modems and acoustic couplers. New models of data modems are being developed constantly and some of the older models are being superseded. Therefore, neither TE & M nor REA can be responsible for the accuracy or completeness of the information. The material, however, should give the reader a comprehensive indication of the equipment that is generally available. Appendices II and III were reprinted by permission of "Telephone Engineer and Management."

## 6. ACOUSTICALLY COUPLED DATA MODEMS

6.1 Most types of data modems are hard wired into the circuit between the customer owned business machine and a network protection device, or directly to the telephone line. Some types, however, are coupled to the telephone line through the telephone handset by means of an acoustic coupler that is built into the data modem. The quality of the transmitted signal from acoustically coupled modems is poorer than that from a hard wired modem because it is affected by the distortion and variability of the carbon transmitter of the telephone set. Acoustically coupled data modems should not be confused with "data couplers" that constitute a portion of a "Data Access Arrangement." Data couplers, used in "Data Access Arrangements" are usually hard wired and provide protection to the DDD network when a customer owned data modem is used under present Bell System tariffs. Data Access Arrangements will be discussed in a separate TE & CM section on inter-connection of customer owned equipment to telephone company lines.

6.2 Acoustically coupled data modems, in addition to the electronic components, generally include a small electro-acoustic transducer (speaker) mounted in a housing that forms a sound muffling cradle for the telephone handset. When the handset is placed in the cradle, the handset transmitter is acoustically coupled to the speaker in the modem. The acoustic data set accepts information from the business machine in the form of d.c. electrical pulses (binary digits or bits), converts these pulses into audio-frequency electrical signals, then to audio tones in the speaker. The audio tones are picked up by the telephone transmitter, reconverted to voice frequency electrical tones, and are transmitted over the telephone circuit. Acoustically coupled data modems offer convenient, reliable, and portable service. Some modems can either transmit or receive (half duplex) at any data rate up to 300 bps, or transmit and receive simultaneously (full-duplex) at rates up to 150 bps, using different frequency bands for sending and receiving. Modems may be powered from the terminal device or from a local 115 volt 60Hz commercial source through an auxiliary assembly. Batteries are not normally used except where portability is important as in the patients' bedside models.

6.3 One type of data modem commonly used for transmitting electro-cardiograms (EKG) is an analog device which functions as follows: The analog signal output from the EKG machine is fed into a dc coupled differential

amplifier in the data modem (Figure 3). The output of the differential amplifier is proportional to the input signal and is applied to a voltage-controlled oscillator whose normal frequency of about 2000 Hz varies linearly with the input signal voltage. This varying frequency signal is converted to acoustic tones by an electro-acoustic transducer (speaker) which is acoustically coupled to the transmitter of the telephone hand set. The acoustic signal is then converted back to an electric signal by the carbon transmitter and is sent over the telephone line to the receiving modem. There it is recovered as a varying voltage which reproduces the original signal at its original amplitude in the receiving EKG machine. A reverse channel receiver is also included in these modems to permit the receiving location to alert personnel at the transmitting location. The reverse channel signal is a single voice frequency tone which actuates supervisory signals at the data transmitting location. (See Figure 3.)

6.4 Portable data stations consisting of a 600 series data modem combined with a business machine can be moved from office to office, or used in remote locations where a fixed data station is not available.

## 7. DATA SYSTEMS

7.1 There are many different equipment units which can be assembled into many combinations to produce data systems to accomplish specified objectives. It is, therefore, impractical in this section to give detailed engineering information on each type of equipment.

7.2 The Bell system uses many different types of data systems and has published Technical References which give detailed information on each of its data modems that are in common use. These Technical References are listed in catalog PUB 40000, and are available to Borrowers and Engineers from American Telephone and Telegraph Company as indicated in paragraph 1.61. Independent equipment suppliers furnish detailed information on their equipment and generally adequate system design information can be obtained on request.

7.3 One practical approach that a borrower faced with a request for data service from a customer could follow would be to request the services of a representative of an independent modem supplier. Another approach would be as follows:

- (1) Determine the customer's basic needs in sufficient detail to ascertain what series of Western Electric equipment would be required if Western equipment were to be used.
- (2) Purchase the applicable "Technical References" from the A. T. & T. Co. to obtain the necessary technical information to develop a firm system proposal.

- (3) Obtain from an independent supplier, equipment which is equivalent to the applicable Western Electric equipment.

## 8. APPLICATIONS

8.1 There are a number of different types of businesses in areas served by rural telephone systems that are good prospects for data systems including the following:

- A. Branch Banks
- B. Warehouses
- C. Factories
- D. Branch Offices of companies (such as insurance, brokerage, and auto rental).
- E. Doctors' Offices
- F. Hospitals
- G. Branch Retail Stores
- H. Public Utilities Offices
- I. Transportation Companies
- J. Law Enforcement Agencies

8.2 Some examples are discussed below.

8.21 A typical application for a branch facility of some centralized business would consist of one or more data input devices in each branch location that would send data to a central computer. Some of these installations would also need a data receiving capability in order to receive data from the computer. In the branch bank application the data system might provide push button telephone sets to enable each teller to query a central computer regarding a customer's account. The central location would have to be equipped with rather elaborate voice-answerback facilities to enable the teller to receive the information verbally through his push button telephone set.

8.22 A factory installation might consist of push button telephone sets installed at various locations throughout the plant. Each of the push button sets would have direct access to a PABX and through a traffic concentration group of trunks, from the PABX to the computer as shown in Figure 4. The PABX trunks would be terminated in Western Electric #403D or #403E (or

equivalent) data set tone receivers. These tone receivers are required at the computer center to decode and translate the incoming push button tone signals into a form that is acceptable to the computer. One type 403 data set is needed for each PABX trunk to the computer. Each push button phone has access to the computer via the PABX 24 hours per day, 7 days per week. The production worker who needs information accesses the computer data terminal by punching one or two digits comprising the inquiry transaction code on his push button phone. Receipt of a high pitched "data tone" from the computer indicates that the connection has been established. The data terminal equipment at the computer center then answers back with the word "Register" which may be a request to enter an 8 digit order control or register number of the job in question.

8.221 After receiving the register number, the computer quickly determines if this is a valid register number. If the computer finds the number is not valid, the data terminal equipment responds with the words "Re-dial Register." The computer will accept three attempts to enter a register number and if on the third attempt, finds that the number is still not valid, advises the user to "Request Aid" from his supervisor and ends the transaction.

8.222 When a valid register number is entered, the data terminal equipment voice response gives details concerning the last recorded move of the order between departments. The information may include the numbers of both the "from" and "to" departments, the manufacturing day and time of both release and receipt, quantity of parts on order, the scheduled completion date, and the part number. For example, in response to an order location and status inquiry, the voice response reply might be:

"From location 1010, date 081, time 1330, to location 1017, date 089, time 1715, quantity 10, completion date 093, part number 3A66025-IK."

The voice response may also provide the user with additional information. This may include a "Priority" classification code or a "Hold" code.

8.223 The voice-answerback system may also be used for collecting labor time and attendance data. For example, when an employee begins his shift, he goes directly to a pushbutton telephone and punches in his badge number. Again this number is automatically checked, and if it is a valid number, the computer answers back, "O.K."; if not, it responds, "Re-Dial Man Number." In addition, each time an employee starts work on a given parts order, he uses the pushbutton telephone to punch in a labor reporting code. The computer then verbally requests the employee's man number, labor classification code, department number, and order register number, signing off with "O.K." after all data has been properly entered.

8.224 A standard pushbutton pad with a 12-button layout is shown on Figure 5. As shown, each button has two frequencies, including



the "\*" button and the "#" button. The caller may send 34 alphanumeric symbols from the 12 buttons. A standard telephone set with a 12 button pad is normally used in voice-answerback systems. A 16 button pad can be furnished on special request if required. Numbers are sent directly by pressing the numbered button while letters are sent by pressing the numbered button that has the letter to be sent, followed by pressing the "#" button one to three times depending upon the position of the letter on the button. For example, to send the letter "K" one would press the "5" button that shows "JKL" followed by pressing the "#" button twice.

8.225 The telephone set used with the voice-answerback computer installation may also be a regular rotary dial key telephone set plus a separately mounted push button dial pad.

8.226 Another telephone set that may be used is the pushbutton card dialer telephone. The card, in this case, may contain information on the part number, the use of the part, date due for production, etc.

8.227 The voice-answerback system operation is half-duplex on two wires. The Western Electric 403D data set (or the equivalent) housing 1 to 16 type 403 receivers is used for multiple data set installations. The 403E receiver (or the equivalent) is a single unit model.

8.228 The computer answers inquiries by a voice vocabulary pre-recorded on a voice-answerback drum unit. In a typical system the drum surface is divided into fixed-length slots of time, and each of these contains one word. A series of magnetic heads are able to pick up the selected words under the control of the computer program. The word sounds are amplified and connected to the telephone line. Where a word occupies more than one slot on the drum, the computer will transmit the appropriate slots sequentially. The word vocabulary is limited by the size of the voice answerback drum. In a typical system the maximum number of words that can be used is 128. Most voice answerback systems use the ASCII code.

8.229 Both of the data systems previously described use standard push button telephone sets to generate the data input. This has the advantage of being inexpensive, but the number of input characters is severely limited by having only 12 buttons. Where a large number of characters must be used for the data input a more elaborate device such as a teletypewriter keyboard must be used. There are many different makes and designs of input/output devices which can be used to connect remote stations to a central computer center to handle customer's accounts. The computer is generally updated by the input/output machine at each remote station. These machines may be permanently connected to the computer on a private line leased from the telephone company or can be connected by a regular exchange line on the switchboard using a telephone dial to first establish the connection.





are not involved except to modulate and demodulate the data signal for transmission over the circuit.

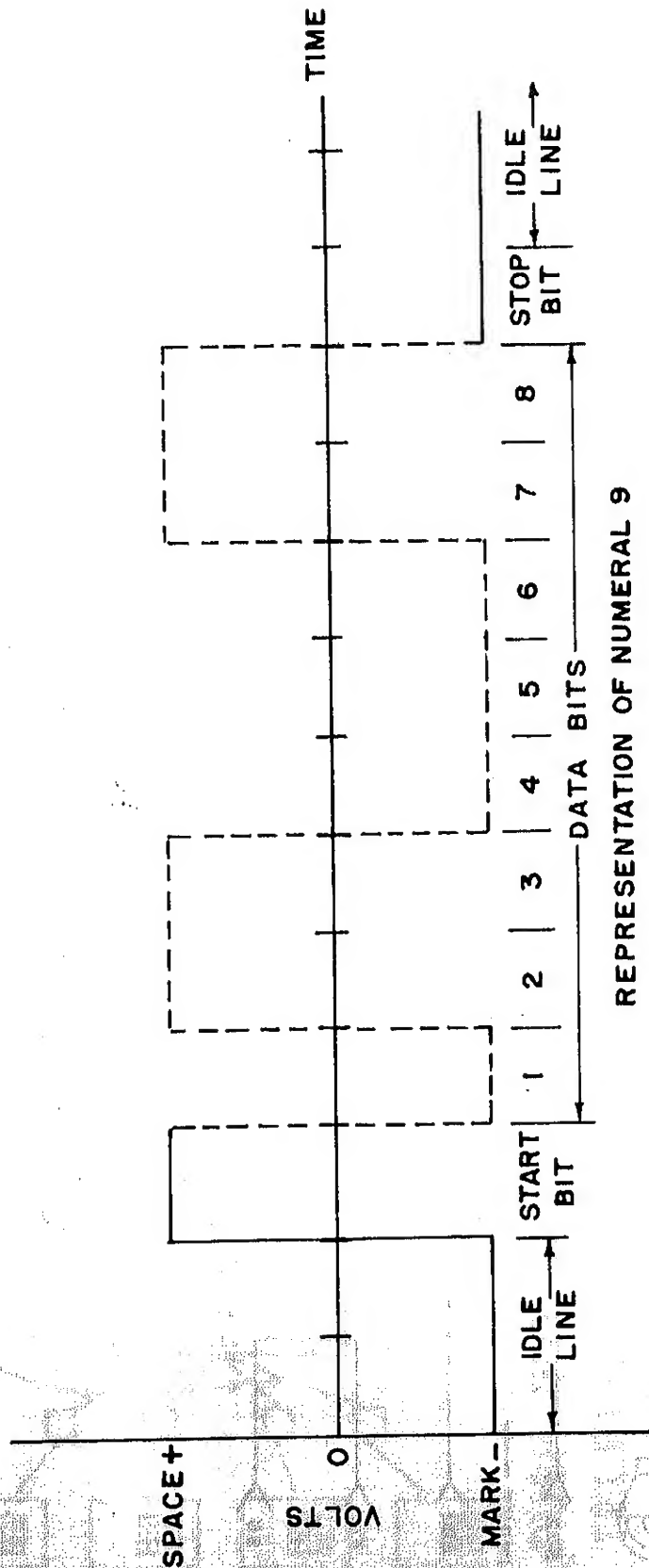


TABLE 1 - VOICE BANDWIDTH DATA CHANNEL AND C-TYPE CONDITIONING

I. Circuit Designation		3002 Channel	C1 Conditioning	C2 Conditioning	C4 Conditioning
Use		Data Only			
II. General Characteristics Type of Service		2-Point or Multipoint	2-Point or Multipoint	2-Point or Multipoint	2, 3 or 4 Points
Mode of Operation Method of Termination Imped.-Source & Load Maximum Signal Power		Half-or Full Duplex 2-Wire or 4-Wire 600-ohm-Resistive-Bal. 0-dBm for Composite Data Signal.			
III. Attenuation Char. (Meas. betw. 600 ohm impedances at lineup) Expected Max. Var.		16 dB $\pm$ 1 @ 1000 Hz  Short-term $\pm$ 3 dB Long-term $\pm$ 4 dB			
Frequency Response (Ref. 1000 Hz)		Freq. Range	Var.-dB	Freq. Range	Var.-dB
		300-3000	-3 to + 12	* 300-2700	-2 to + 6
		500-2500	-2 to + 8	* 1000-2400	-1 to + 3
				2700-3000	-3 to + 12
Frequency Error		$\pm$ 5 Hz			
IV. Delay Characteristics Absolute delay		Not Specified			
Env. delay distortion		Freq. Range	$\mu$ Sec.	Freq. Range	$\mu$ Sec.
		800-2600	<1750	* 1000-2400	< 500
				800-2600	<1500
				* 600-2600	<3000
				* 500-2800	* 500-3000
					* 500-3000
V. Noise Characteristics Message Circuit Noise Impulse Noise		0-50 Miles - 31 dBmC 15 counts in 15 minutes @ 72 dBmC0			

\* These specifications are covered by Interstate Tariff FCC No. 260 (1/1/69).  
All others are the current administrative instructions of A.T.& T. Co.





10 BIT ASYNCHRONOUS TRANSMISSION CODE  
WITH START & STOP BITS

FIGURE 2

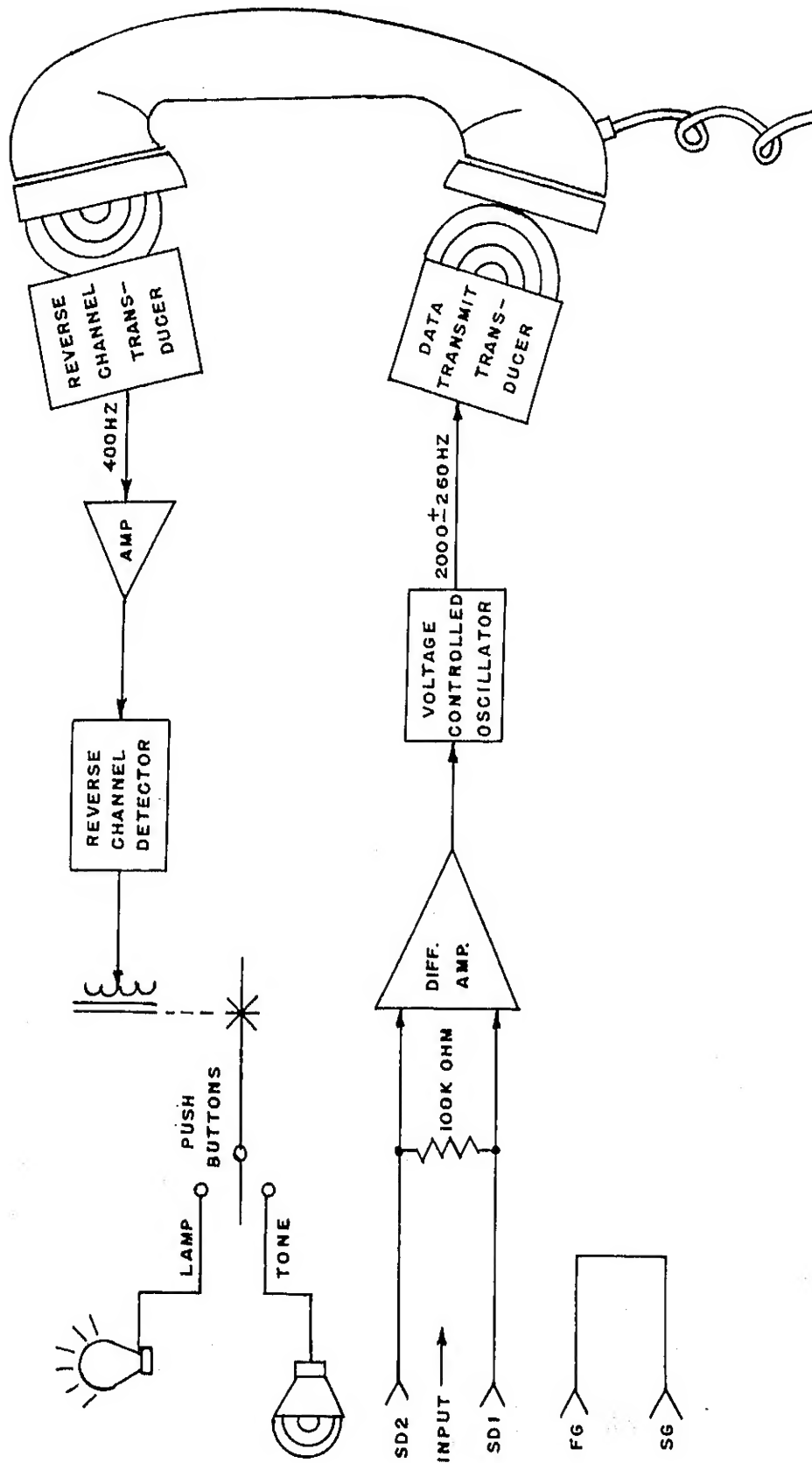
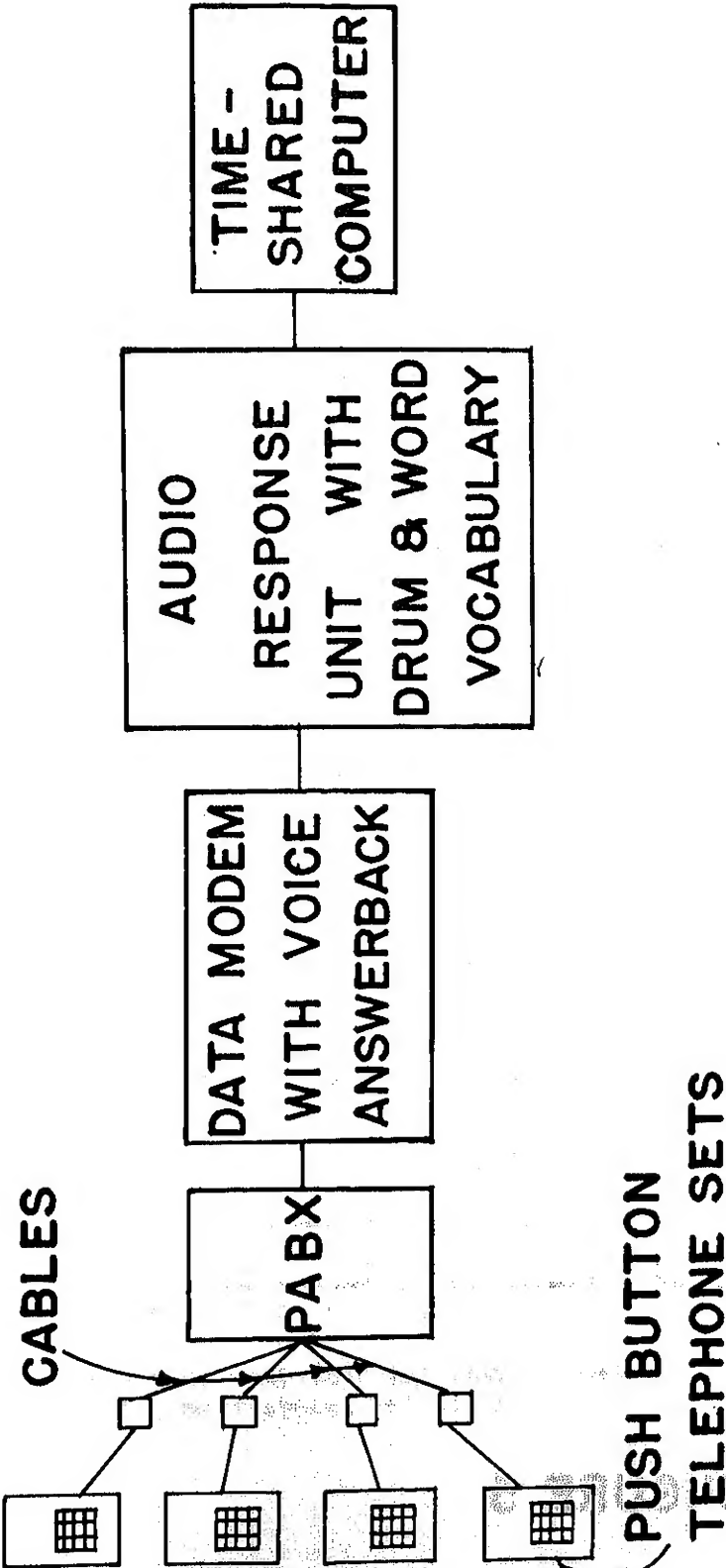


Fig. 3 ACOUSTICALLY COUPLED ANALOG DATA MODEM  
FUNCTIONAL DIAGRAM





FACTORY DATA SYSTEM  
FIGURE 4

# PUSH BUTTON DIAL CHARACTERS AND FREQUENCIES

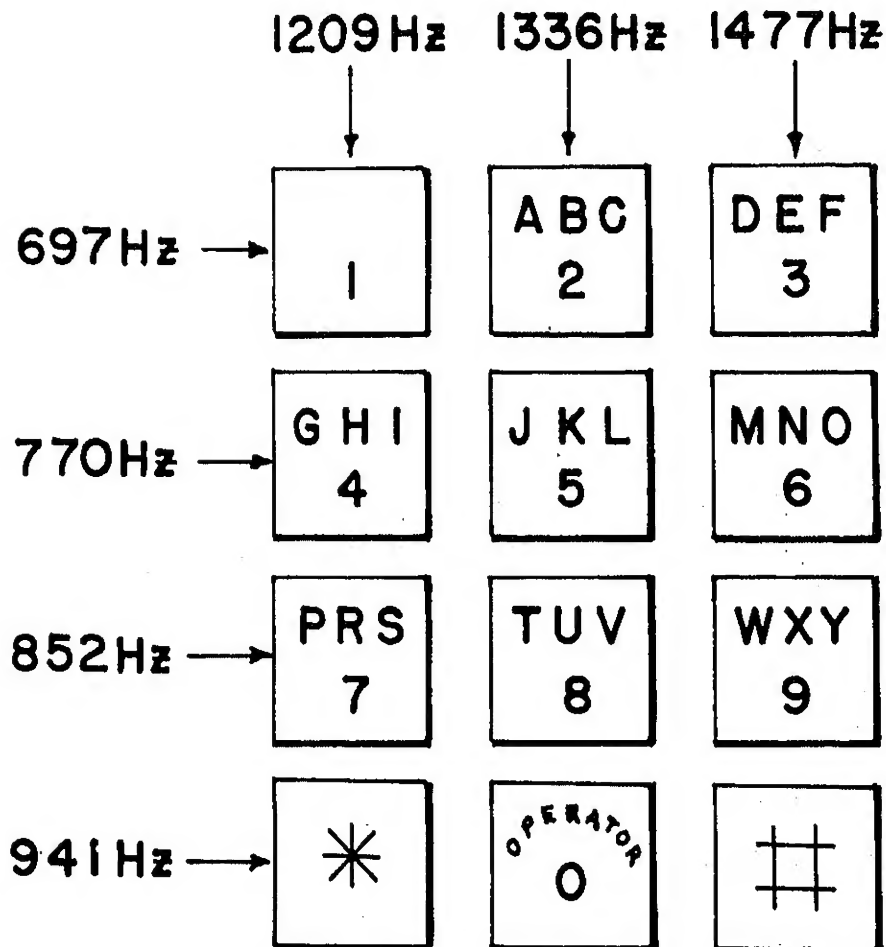


FIGURE 5

This appendix covers a brief summary of terminology definitions commonly used in data communications.

**ALPHANUMERIC** - (1) A contraction of alphabetic-numeric; (2) pertaining to a character set that contains both letters and numerals and usually special characters.

**AMPLITUDE MODULATION (AM)** - A form of modulation in which the amplitude of the carrier is varied in accordance with the amplitude of the original information signal.

**AMPLITUDE SHIFT KEYING (ASK)** - A form of modulation in data communications where the amplitude of an audio carrier is shifted between two discrete levels by the digital signal to represent a mark (binary "1") or a space (binary "0").

**ANALOG** - Pertaining to data in the form of continuously variable physical quantities. Contrasts with Digital.

**ANSWER-BACK** - A signal transmitted by the receiving device back to the sending device to indicate that the receiver is ready to accept or acknowledge the receipt of data.

**ASCII** - American Standard Code for Information Interchange.

**ASYNCHRONOUS TRANSMISSION** - Transmission in which each information character or sometimes each word or small block is individually synchronized, usually by the use of start and stop elements. The gap between each character (or word) is not of a necessarily fixed length. Asynchronous transmission is also called "start-stop transmission."

**AUDIO RESPONSE** - A system of generating an audible, verbal output from a machine.

**BAUD** - Unit of signaling speed. The speed in bauds is the number of discrete conditions or signal events per second. (This is applied only to the actual signals on a communication line.) If each signal event represents only one bit condition, baud is the same as bits per second. When each signal event represents other than one bit, (e.g. see Dibit) baud does not equal bits per second.

**BAUDOT CODE** - Referred to as "5-bit code," this is a system for encoding symbols in printing telegraphy.

**BINARY** - A code that uses information that has only two distinct states, e.g., on-off, mark-space, yes-no, 1-0.

BIT - (1) An abbreviation of binary digit. (2) A signal character in a binary number. (3) A signal pulse in a group of pulses. (4) A bit represents the choice between a mark of space (one or zero) condition.

BIT-SERIAL - The form of information transfer where each bit is transmitted sequentially.

BUFFER - (1) A storage device used to compensate for a difference in rate of flow of data or time of occurrence of events when data is transmitted from one device to another.

BUSINESS MACHINE - Office machine equipment normally owned by the customer and used in business offices for storing and/or processing data. It may or may not be a part of a communication system.

BYTE - A group of binary digits which is the smallest addressable unit of information in a memory.

CHARACTER - The actual or coded representation of a digit, letter, or special symbol. One symbol of a set of elementary symbols such as those corresponding to the keys on a typewriter. The symbols usually include the decimal digits 0 to 9, the letters A to Z, punctuation marks, operation symbols, etc.

CIRCUIT, MULTIPOINT - A system consisting of a circuit connecting three or more terminals, any or all of which may simultaneously receive information.

CODE - A system of symbols for meaningful communication, such as representing data or instructions to a computer.

COMMON LANGUAGE - A machine sensible information representation which is common to a related group of data processing machines.

COMPUTER - A device capable of accepting information, applying prescribed processes to the information and supplying the results of these processes. It usually consists of input and output devices, memory storage, arithmetic, logic, and control units.

CONDITIONING, LINE - Actions taken and/or equipments provided to correct circuit distortion levels, or impedances to established standards.

CONNECTING ARRANGEMENT - Equipment provided by the telephone company which is interposed between customer-provided facilities and facilities of the telephone company to protect the telephone network.

DATA COMMUNICATION - The transmission of information to and from data processing equipment. This includes selection, assembly, sequencing, and routing of data at one point and transmission of the data in a prescribed mode and format to a remote point or points for processing. It also includes the distribution of processed data from a computer or other processor to remote terminals or other data processing equipment.

- DATA SET** - A device which converts the signals from a business machine to signals that are suitable for transmission over communication lines. It also converts signals from communication lines to signals suitable for a business machine. Performs related functions.
- DATA TRANSMISSION** - The sending of data from one part of a system to another.
- DECODE** - To determine the meaning of individual characters or groups of characters in a message through the reversal of some previous coding.
- DEDICATED** - Permanently assigned. In data transmission it usually refers to leased or private communication lines or equipment.
- DEMODULATION** - The reverse of modulation. The process of retrieving the original signal from the communication channel.
- DIBIT** - A group of two bits. In four-phase modulation each possible dibit is encoded as one of four unique carrier phase shifts. The four possible states for a dibit are 00, 01, 10, and 11.
- DIGIT CHECK** - A redundant digit (or digits) carried within a unit item of information (character, word, block, etc.,) which provides information about the other digits in the unit in such a manner that if an error occurs the check fails.
- DIGITAL** - Information expressed as a sequence of discrete elements. Pertaining to data in the form of digits.
- DIRECT ELECTRICAL CONNECTION** - Denotes a physical connection of the electrical conductors in the communications path.
- DOWN-TIME** - The period during which a computer or other data equipment is malfunctioning or not operating correctly due to mechanical or electronic failure as opposed to available time, idle time, or stand by time, during which the computer is functional.
- DUPLEX OPERATION** - Full-duplex operation provides for transmission of data in two directions simultaneously. Half-duplex operation allows two-way transmission, but in only one direction at a time.
- DUOBINARY** - A coding system that makes possible a doubling of transmission speed over a communication channel. Duobinary coding techniques permit detection of errors without the addition of error-checking bits to characters.
- EDP** - Electronic Data Processing.
- ERROR** - An occurrence during transmission such that different information is received than was transmitted; a mistake.
- ERROR-CORRECTION** - A system that automatically detects and corrects errors.

**ERROR-DETECTION** - A system that automatically detects and identifies errors.

**ERROR RATE** - The probability of an error occurring during the transmission of a message. Error rates of  $10^{-5}$  (one error in 100,000 bits) are typical.

**FREQUENCY MODULATION(FM)** - A form of modulation in which the frequency of the transmitted signal is varied in accordance with the information being transmitted.

**FREQUENCY SHIFT KEYING (FSK)** - A form of modulation in data communications where an audio carrier is shifted between two discrete frequencies by the digital signal to represent a mark (binary "1") or a space (binary "0").

**HALF-DUPLEX** - See Duplex

**HARD COPY** - A tangible, printed copy of data information.

**HARDWARE** - The equipment that comprises a data processing system. It is most frequently used to differentiate between the physical features of the system and those which the user introduces through coding and programming.

**IMPULSE NOISE** - Any burst of high amplitude closely spaced impulses, followed by a relatively quiet period. The objectives for impulse noise limits are stated in the number of counts (bursts) above a given threshold. An average impulse rate of 1.5 counts per minute results in an error rate of  $10^{-5}$ . The impulse noise rate is determined by using commercially available impulse noise counters. Improvements in the signal-to-impulse noise ratio can be obtained by shortening the repeater spacing near the central office.

**INFORMATION CHANNEL** - The transmission and intervening equipment involved in the transfer of information in a given direction between the two terminals.

**INPUT** - The information fed into a computer system, data to be processed, the device or devices used to bring data into another device.

**INPUT/OUTPUT** - A general term for the equipment and the data involved in a communication system.

**INTERCHANGE CIRCUIT** - A circuit between the data terminal equipment and the data communication equipment for the purpose of exchanging data, control, or timing signals.

**INTERFACE** - The point of connection between the business machine equipment and the communications channel; a common boundary between the two parts. This is where the customer's equipment and the data set meet. Compatibility is essential; the data set must be able to accept the output signal of the customer's equipment and vice versa.

JITTER - See Phase Jitter

LEASED LINE - A facility reserved for sole use of a single leasing customer

MEMORY - A general term for equipment that holds or stores data in electrical or magnetic form.

MESSAGE - A group of words, variable in length, transported as a unit. In telegraphic and data communications a message may be composed of three parts.

1. A heading, containing a suitable indicator of the beginning of the specific message, together with information on any or all of the following: The source and destination, date and time of filing, and routing or other transmission.
2. A body containing the information to be communicated.
3. An ending containing a suitable indicator of the conclusion of the specific message, either explicit or implicit.

MESSAGE ROUTING - The function performed at a central message processor of selecting the route, or alternate route if required, by which a message will proceed to the next point in reaching its destination.

MODE - Method of operation.

MODEM - A contraction of modulator-demodulator used to describe equipment containing both.

MODULATION - The process in which a signal suitable for transmission over the communication medium is altered in a definite pattern in accordance with the information being transmitted.

NETWORK CONTROL SIGNALING UNIT - Denotes the terminal equipment to provide for network control signaling. Usually a dial on a telephone set.

OFF-LINE - Implies no direct connection between the communication line and the computer system or equipment.

ON-LINE - Implies a direct connection between the communication line and the computer system.

OUTPUT - The results of computer calculation or operations that are conveyed to peripheral devices such as printers.

PARALLEL OPERATION - A method of transferring information in which all parts of a character (or message) are handled simultaneously. A parallel data set accepts and transmits an entire character at once.



PARITY CHECK - A means of detecting errors in received data. Binary "ones" are added to the transmitted character so that the total number of binary "ones" is always odd or always even. At the receiving end, the sum is rechecked to determine if it is still odd or even.

PERIPHERAL EQUIPMENT - Equipment that works in conjunction with a computer but is not part of the computer itself, e.g., card punches and readers.

PHASE JITTER - A form of distortion in which the transmitted signal is phase modulated by noise. The effective noise occurs in the bandwidth from 0 to 300 Hz and typically occurs at the ringing and powerline frequencies and their harmonic frequencies. The 120 Hz component is often the dominant component. Phase jitter also appears as bursts of **noise** commonly referred to as phase hits. Principal sources of phase jitter are frequency division multiplex equipment and to a lesser degree automatic equalizer and associated equipment. At data rates of 3600 bps and above phase jitter may have a significant effect. Proper data set design can minimize the effect of phase jitter. The term "phase jitter" is usually used in analog data transmission. (See also Timing Jitter)

PHASE MODULATION (PM) - A form of angle modulation where the instantaneous phase of the carrier signal is varied in accordance with the information signal.

PHASE SHIFT KEYING (PSK) - A form of modulation in data communications where the instantaneous phase of an audio carrier is shifted between two discrete values by the digital signal to represent a mark (binary "1") or a space (binary "0").

POLLING - A technique used for collecting and disseminating data between a central processor (computer) and a number of remote stations. The computer is programmed to originate a request for data to each remote station in sequence, or requests each remote station to put itself in a condition to receive data.

PRIVATE LINE - Denotes the channel and channel equipment furnished to a customer as a unit for his exclusive use without interchange switching arrangements.

PROGRAM - As a noun, it means a list of instructions to be followed by a computer. As a verb, it means to prepare a program, the complete sequence of machine instructions and routines necessary to solve a problem.

PULSE - A signal of short duration generally characterized by a sharp rise and decay time of a quantity whose value is normally constant.

PULSE CODE MODULATION (PCM) - The process of converting an analog signal to a digital code.

- QUEUING - To hold calls for an operator then to present them to the operator sequentially in the order received.
- READOUT - The display of the output of a computer.
- REAL TIME - A data processing system that analyzes and processes input data as soon as it is generated.
- REMOTE - Input/Output equipment which is physically separated from the computer by a considerable distance.
- REVERSE CHANNEL - A channel which provides a means of signaling or communicating in the reverse direction. This is intended for use in systems where error checking or monitoring is desired.
- REDUNDANCY CHECK - An automatic or programmed check based on the systematic insertion of components or characters used especially for error checking purposes.
- SERIAL-PARALLEL - A combination of serial and parallel; e.g., serial by character parallel by bit, descriptive of a device which converts a serial input into a parallel output.
- SERIAL TRANSMISSION - A system of transmitting the bits of a character on the line in sequence, generally used in telegraphic operations. A serial data set handles only one bit at a time.
- SOFTWARE - Paperwork, procedures, and other non-equipment items necessary for a data system. All programs and routines used to extend the capabilities of computers such as compilers, routines, etc.
- SPEED OF TRANSMISSION - The rate at which data is sent over a transmission facility expressed as the average rate over some significant time interval. The quantity is usually expressed as average characters per second or average bits per second.
- STORAGE - The portion of a data processing system that records, holds, and allows access to information.
- SYNCHRONOUS - Pertaining to two or more machines operating in the same period and phase.
- TERMINAL - A point in a system or communication network at which data can either enter or leave; an input/output device capable of transmitting entries to and obtaining output from the system of which it is a part.
- TIMING JITTER - A term used in digital transmission for distortion caused by random phase modulation which is introduced at each repeater cumulatively. Sources of timing jitter include inter symbol interference, finite pulse width, clock threshold offsets, and timing degradation. (See Phase Jitter).

VESTIGIAL SIDEBAND - A type of amplitude modulation where a prescribed portion of one side band is suppressed, VSB is used on high speed data modems - 3600 bps and above.

VOICE-ANSWERBACK - A computer system whereby a computer answers inquiries by a voice vocabulary pre-recorded on a voice-answerback drum unit.

WORD - In computing, a sequence of bits or characters treated as a unit and capable of being stored in one computer location; ordered set of characters, normally digital, which is the normal unit in which information may be stored, transmitted, or operated upon within a computer.

# QUICK REFERENCE TO BELL SYSTEM DATA SETS



DATA SET	TRANS (T) REC (R)	MAX SPEED (bits/sec)	SERVICE: DIAL PRIVATE	PRINCIPAL USE
<u>Voiceband: digital-serial (100 &amp; 200 Series)</u>				
103A	T-R	300	DDO & PL	TTY, low-speed, binary, non-clocked device
103C	T-R orig & ans	300	DDO & PL	Multi arr, cab mtd, for low-sp times-shared com ports term
103F	T-R	300	DDO & PL	TTY, low-sp binary, non-clocked devices
103H	T-R	300	DDO & PL	Built-in var 103G for Use/W #37 TTY or custom mach
113A	T-R orig	300	DDO & PL	TTY, low speed binary, non-clocked devices
113B	T-R ans	300	DDO & PL	Multi arr, cab mtd for low sp time-shared com ports term
201A	T-R	2000	DDO & PL	Med Speed mach binary, sync devices
201B	T-R	2400	PL	Med sp mach binary, sync dev on multi-pt layouts
202C	T-R	1200/1800	DDO/PL	Med speed, binary, non-sync devices
202D	T-R	1800	PL	Med binary non-sync dev on multi-pt layouts
202E	T	1200/1800	DDO/PL	Low cost, med speed, binary non-sync trans device
202R	T-R	1800	DDO/PL	Med sp, binary, sync dev on multi-pt layout-sing or mult
203A	T-R	3600/7200	DDO/PL	Med speed, binary, sync device
102B	T	3600/7200	DDO/PL	Med speed, binary, sync device
203C	R	3600/7200	DDO/PL	Med speed, binary, sync device
208A	T-R	4800	PL	Med sp bus mach, binary, sync dev on multi-pt layouts

## Voiceband: digital-parallel (400 Series)

401A	T	90	DDO & PL	Low-cost, low speed, non-sync dev with 24 character req
401E	T	130	DDO & PL	Low-cost, low speed, non-sync dev with 99 char, att. oper
401H	T	130	DDO & PL	Remote, non-sync, telemetry dev
401J	R	130	DDO & PL	Low sp non-sync data col center dev serv remote term
401L	T	130	DDO	Alarm reporting terminal equipment
402C	T	600	DDO & PL	Tape sending device to channels binary data
402D	R	600	DDO & PL	Tape receiving dev to channels binary data
403D	R	40	DDO & PL	Receiver for multi data set collec or audio resp system
403E	R	40	DDO & PL	Individual receiver for sm data collec or audio resp sys

## Voiceband: analog (600 Series)

602C	T-R	-	DDO & PL	Fax or telemetry sending or rec dev w one ch or info 0-1000HZ
603A	T	-	DDO & PL	Fixed EXG sending dev with 1 ch of info, 0-100HZ
603B	T	-	DDO & PL	Fixed EXG receiving dev with 1 ch of info, 0-100HZ
603D	T	-	DDO	

## Wideband: digital-serial (300 Series)

301B	T-R	40,800	PL	High-sp, binary, sync bus mach or 2-lev hl sp fax dev
301B	T-R	19,200	PL	High-sp, binary, sync or non-sync business mach
303C	T-R	80,000	DATA-PHONE 50 PL	High-sp, binary sync bus mach or 2-lev hl-sp fax dev
303D	T-R	230,400	PL	High-sp, binary, sync bus mach

### TYPE

Manual	S R	DDO	Ac analog device
Automatic	S R	DDO	Dev employing contact closures for control leads
Automatic	S R	DDO	Dev employing EIA RS 232B interface

### VOICEBAND DATA ACCESS ARRANGEMENTS

### TYPE AUTOMATIC CALL

801A	Rotary Dial	Da Sls 103A/E/G/H, 201A, 202C/D, 203A/B/C, 401J, 402C/D, 403E&602C
801C	TOUCH-TONE Dial	Da Sls 103A/E/G/H, 201A, 202C/D, 203A/B/C, 401J, 402C/D, 403E&602C

### DATA AUXILIARY SETS

### APPROXIMATE MONTHLY RATES

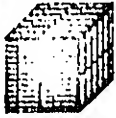
DATA DATA- SET PHONE SERVICE	PL SYN	REMARKS	DATA DATA- SET PHONE SERVICE	PL SYN	REMARKS
103A	\$ 25	\$ 20	401H	\$ 9	\$ 11
103C	\$ 21	\$ 20	401	\$ 40	\$ 40
103F			401L	\$ 20	
103H	\$ 35		402C	\$ 20	\$ 24
113A	\$ 10		402D	\$ 60	\$ 53
113B	\$ 11	\$ 11	4030	\$ 37	
201A	\$ 70	\$ 72	403C	\$ 53	
201B	\$ 72		602C	\$ 30	\$ 28
202C	\$ 35	\$ 30	603A	\$ 12	\$ 16
202E	\$ 14	\$ 14	603B	\$ 12	
202R	\$ 20	\$ 25	801A	\$ 25	
203 A-B-C			801C	\$ 25	
208A	\$115	\$115			
301B	\$425	\$425			
301B	\$425	\$425			
303C	\$275	\$425			
303D	\$450	\$450			

### DATA ACCESS ARRANGEMENTS

Manual	2	Control lead signals conform to EIA RS 232B
Auto	8	Contact clo used for cont leads without power prov by Telco
Auto	4	Contact clo used for cont leads with power prov by Telco
Auto	5.50	

## Appendix II





# Buyer's Guide to Data Modems and Acoustic Couplers

MODEL	MODEM/ACOUSTIC COUPLES	SPEED- MIN/MAX	MODULATION SYNCH-ASTRICH	CHANNEL/ COMBINING	DUPLEX/SIMPLEX	BUILT-IN EQUALIZATION	MOUNTING/ OWN CARD AVAILABLE	DIMENSIONS (inches)	COMPATIBLE w/BELL	PRICE	BITS/SECOND /DOLLAR	FEATURES	
Acrodyn Data Devices, Inc. Union City, N.J. 201-773-2012	YTC-1 YTC-2 AHT-1 AHT-2	A M M M	300 Max 300 Max 300 Max 300 Max	FM-S FM-S FM-S FM-S	Voice Voice Voice Voice	No No HD4FD No	Cab-No Cab-No Cab-No Cab-No	10x10x5 10x10x5 10x10x5 10x10x5	101A & 102F & 113			Orig Only Orig & Ans Orig Unattend Orig & Ans	
American Data Systems 8851 Mason Ave Canoga Park, Ca. 213-882-0020	403/2 44B/IV 412 424	M M H M	0/300 2400/4800 0/1200 1200/2400	FM-ASYNC DSSC-PH & AM-SYNC FM S/A PM-S	Voice Voice Voice Voice	FD FD FD-4W HD-2W	Desk Cab or 3 cards 1 card 2 cards	4x10x12 4x10x12 8x10 6x9 6x9	103 2020 201B	\$ 400 2400 430 800	\$.75 .06 2.8 3.0	Uses HOS-651 Reverse 150 B Channel (Enclosure)	
Anderson Jacobson 1065 Horse Ave. Sunnyvale Ca. 408-734-4020	ADA6- 1200/1210 DCH150 ADC-300	A/M M A/M	0/1200 0/150 0/300	FM-A FM-A FM-A	Voice 5 m Voice	HD No HD	No No No	Cab-No Cab-No Cab-No	4x10x11 7x11x24 12x12x5 1/2	2026 103A	\$ 349 695	\$.43 .43	For Short private conn Walnut Cab.
Astrocom Corp. 393 Commercial St. Paul, Minn. 612-227-8991	110/130 112 320/324 348 120 5C200 400	A/M A M H H M M	0/300 0/1200 2000/2400 2400/4800 0/1800 2000/9600 10K/100K	FM-A FM-A PM-S QAM-S FM-A PM-S PM-S	Voice Voice Voice Voice Abv 1400C-2 Private Private	FD HD HD/HD FD-4W HD/HD HD/HD	No No Optional Compro Han or Adaptive Compro No No	Cab-Yes Cab-Yes Cab- Rack-Yes Cab-No Cab,Ra,Y Cab,Ra,Y Cab,Ra,Y	3x11x10 4x12x14 7x11x10 1/4 7x11x10 1/4 3x11x10 3x11x10 7x11x10	103 202 201 No 202 No No	\$ 850 1200 4400 to 5700 \$ 830 1825	\$1.41 2.00 1.1 1.7 5.5 -	Limited Distance Limited Distance
Bowmar/All, Inc. Acton, Mass.	6103A 6000A	H H	0/300 1200/2400	FM-A PM-S	Voice Voice	HD/HD HD/HD	No Yes	Cab, Yes Cab, Yes	4x13x12 4x9 1/2	103 No	\$ 645 1250	\$.47 1.92	
Carlerfone Communications Dallas, Texas	DS103A H8132	II H	0/440 0/300-440	FM-A FM-A	Voice Voice	HD/HD HD/HD	No No	In TTY Cab,Ra,Y Card Cage	14x17x2 1016 103E	103 1016 103E	\$ 550 600	\$.80 .74	Auto Ans Self Test TTL Interface Available
Codex Corp. 15 Riverdale Ave Newton, Mass. 617-869-0600	4800 7200 9600 4800 Multipl 4800 Dial	M M M II H	3200/4800 4800/7200 4800/9600 4800 4000	QAM-S QAM-S QAM-S QAM-S QAM-S	Voice Voice Voice Vo Multipl Switch-Vol	FD/4D FD/4D FD/4D FD/4D FD/4D	Auto Dig. Adaptive " " "	Rack,Cab (9 cards) " " " "	19x7x20 1/2 19x7x20 1/2 19x7x20 1/2 19x7x20 1/2 19x7x20 1/2	No No No No No	\$5575 8000 11,500 5575 5975	\$.86 .90 .83 .86 .80	M11 188 Interface Avail. Equalizer Updates 2400 times per second 50 MSEC Equalization Auto-Answer
Collins Radio Co. Hempstead Beach Co. 714-833-0600	THA202C THA202E TE-236	M H H	0/150 0/300 1200 or 2400	FM-A FM-A DCPSK-S	Vo (10Ch) Vo (8Ch) Voice	HD/HD HD/HD HD/HD	No No Yes	Ra,Cab,Y " Ra,Cab,Y	4x14x11 (2 Ch) (2 Ch)	No No 201B	\$ 700 1117 1750	\$.21 to 1.27	
Com Data Corp. 7544 W. Dekton Miles, Ill. 312-692-6107	201F4-13 302A2-13 302B2-13 302F2-13 33002-43 330F2-13 302F2-33 30202-43 301P2-11 310 320 450F2-13 150A2-11	M A A/M H H H H H H A/M A/M H A	0/300 0/300 0/300 0/300 0/300 0/300 0/300 0/300 0/300 0/300 0/300 0/450 0/150	FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A	Voice Voice Voice Voice Voice Voice Voice Voice Voice Voice Voice Voice Voice	FD FD FD FD FD FD FD FD FD FD FD FD FD	No No No No No No No No No No No No No	Cab-Yes Cab-Yes Cab-Yes Cab-Yes Card Card Cab-Yes Cab-Yes Kit Card Card Cab-Yes Cab-Yes	12x4x6 Card 4x10 1/4 12x4x6 12x4x6 12x4x6 4x13 3/4 4x13 3/4 12x4x6 12x4x6 12x4x6 4x5 4x10 1/4 4x10 1/4 3x11x3	101C 103/113 " " " " " " " " " 103/113	\$ 425 245 265 245 195 175 295 325 245 125 150 395 147	\$.75 1.22 1.13 1.22 1.55 1.02 .93 .22 2.40 2.00 .76	Up to 14 Channels/Voice RS-232/TTY RS-232/TTY RS-232/TTY CST/CBS Private line CST/Private line CST/CBS Fits Teletype O.E.M. O.E.M. Auto Answer
Communications Logic, Inc. 6400 Westpark Suite 355 Houston, Tex. 713-785-8100	L-2400 L303A-4 L303C-4 L306C-4 L3000-4 L300C-4 L300F-4 L1800	II A A/M H H H H H	2400 Max 0/300 0/300 0/300 0/300 0/300 0/300 0/1800	PM-S FM-A FM-A FM-A FM-A FM-A FM-A FM-A	Priv-C2 Voice Voice Voice Voice Voice Voice Voice	FD/HD/S HD/HD HD/HD HD/HD HD/HD HD/HD HD/HD	Compro No No No No No No No	Cab-Yes Cab-Yes Cab-No Cab-No Card Cab-Yes Card Card Cab-Yes Cab-Yes	12x13x7 10x11x1 1/2 4x1 6x8 6x8 10x11x1 1/2 6x8 4x5 4x10 1/4 3x11x3	103 " " " " 202	795 190 210 190 110 230 150 350 525	3.01 1.57 1.42 1.57 2.54 1.30 2.00 5.14 3.42	1-Orig Only/2-Rec Only Auto Answer Auto Answer Rev-Chan. Auto Answer
Computer Trans- mission Corp. 2352 Utah Ave. El Segundo, Ca. 213-973-2222	911 915 916 917 1013 1015 1016 1017 900 931 935 936 937 1031 1035 1036 1037	M M M M M M M M M M M M M M M M M	0/1800A 2400/9600S kbps-20kbps 20kbps to 250kbps to 1mbps 0/1800A 2400/4800/ 9600kbps S To 20kbps 20/250kbps 250/1mbps	PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S PCM-S	Wire Pns Wire Pns " " " " " " " " " " " " " " " "	FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD FD/HD	NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA	Cab Cab Cab Cab Cab Cab Cab Cab Cab Cab Cab Cab Cab Cab Cab Cab	4x16x12 " " " optical- 5x12x19 Interface- 4x16x12 " " 10x20x22 7 3/4x10 1/2 " " " " " "	No No No No No No No No No No No No No No No No	\$1850 1850 1950 2200 2950 2950 3300 3700 1900 1150 1150 1150 1250 1500 2400 2400 2650 3050		Continued on next page

## Appendix III

**Continued**

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# Appendix III

## Buyer's Guide to Data Modems and Acoustic Couplers

Continued

MODEL	MODEM/ACOUSTIC COUPLER	SPEED- MIN/MAX	MODULATION TECHNIQUE	CHANNEL/ CONDITIONING	DUPLEX/SIMPLEX	BUILT-IN EQUALIZATION	MOUNTING/ DESK CARD AVAILABLE	DIMENSIONS (inches)	COMPATIBLE w/BELL	PRICE	BITS/SECOND /DOLLAR	FEATURES
Phonplex Corp. Huntington, N.Y.	DPM-1300	M	-0/1300		HD/FD							Combined Vo & Dat Tran
Pratt Electronics Corp. 798 San Antonio Palo Alto, Ca. 415-337-0490	DC-22 P103A P103B P103C P103D P103E P103F P103G P103H P103I P103J P103K P103L P103M P103N P103O P103P P103Q P103R P103S P103T P103U P103V P103W P103X P103Y P103Z P104A P104B P104C P104D P104E P104F P104G P104H P104I P104J P104K P104L P104M P104N P104O P104P P104Q P104R P104S P104T P104U P104V P104W P104X P104Y P104Z P105A P105B P105C P105D P105E P105F P105G P105H P105I P105J P105K P105L P105M P105N P105O P105P P105Q P105R P105S P105T P105U P105V P105W P105X P105Y P105Z P106A P106B P106C P106D P106E P106F P106G P106H P106I P106J P106K P106L P106M P106N P106O P106P P106Q P106R P106S P106T P106U P106V P106W P106X P106Y P106Z P107A P107B P107C P107D P107E P107F P107G P107H P107I P107J P107K P107L P107M P107N P107O P107P P107Q P107R P107S P107T P107U P107V P107W P107X P107Y P107Z P108A P108B P108C P108D P108E P108F P108G P108H P108I P108J P108K P108L P108M P108N P108O P108P P108Q P108R P108S P108T P108U P108V P108W P108X P108Y P108Z P109A P109B P109C P109D P109E P109F P109G P109H P109I P109J P109K P109L P109M P109N P109O P109P P109Q P109R P109S P109T P109U P109V P109W P109X P109Y P109Z P110A P110B P110C P110D P110E P110F P110G P110H P110I P110J P110K P110L P110M P110N P110O P110P P110Q P110R P110S P110T P110U P110V P110W P110X P110Y P110Z P111A P111B P111C P111D P111E P111F P111G P111H P111I P111J P111K P111L P111M P111N P111O P111P P111Q P111R P111S P111T P111U P111V P111W P111X P111Y P111Z P112A P112B P112C P112D P112E P112F P112G P112H P112I P112J P112K P112L P112M P112N P112O P112P P112Q P112R P112S P112T P112U P112V P112W P112X P112Y P112Z P113A P113B P113C P113D P113E P113F P113G P113H P113I P113J P113K P113L P113M P113N P113O P113P P113Q P113R P113S P113T P113U P113V P113W P113X P113Y P113Z P114A P114B P114C P114D P114E P114F P114G P114H P114I P114J P114K P114L P114M P114N P114O P114P P114Q P114R P114S P114T P114U P114V P114W P114X P114Y P114Z P115A P115B P115C P115D P115E P115F P115G P115H P115I P115J P115K P115L P115M P115N P115O P115P P115Q P115R P115S P115T P115U P115V P115W P115X P115Y P115Z P116A P116B P116C P116D P116E P116F P116G P116H P116I P116J P116K P116L P116M P116N P116O P116P P116Q P116R P116S P116T P116U P116V P116W P116X P116Y P116Z P117A P117B P117C P117D P117E P117F P117G P117H P117I P117J P117K P117L P117M P117N P117O P117P P117Q P117R P117S P117T P117U P117V P117W P117X P117Y P117Z P118A P118B P118C P118D P118E P118F P118G P118H P118I P118J P118K P118L P118M P118N P118O P118P P118Q P118R P118S P118T P118U P118V P118W P118X P118Y P118Z P119A P119B P119C P119D P119E P119F P119G P119H P119I P119J P119K P119L P119M P119N P119O P119P P119Q P119R P119S P119T P119U P119V P119W P119X P119Y P119Z P120A P120B P120C P120D P120E P120F P120G P120H P120I P120J P120K P120L P120M P120N P120O P120P P120Q P120R P120S P120T P120U P120V P120W P120X P120Y P120Z P121A P121B P121C P121D P121E P121F P121G P121H P121I P121J P121K P121L P121M P121N P121O P121P P121Q P121R P121S P121T P121U P121V P121W P121X P121Y P121Z P122A P122B P122C P122D P122E P122F P122G P122H P122I P122J P122K P122L P122M P122N P122O P122P P122Q P122R P122S P122T P122U P122V P122W P122X P122Y P122Z P123A P123B P123C P123D P123E P123F P123G P123H P123I P123J P123K P123L P123M P123N P123O P123P P123Q P123R P123S P123T P123U P123V P123W P123X P123Y P123Z P124A P124B P124C P124D P124E P124F P124G P124H P124I P124J P124K P124L P124M P124N P124O P124P P124Q P124R P124S P124T P124U P124V P124W P124X P124Y P124Z P125A P125B P125C P125D P125E P125F P125G P125H P125I P125J P125K P125L P125M P125N P125O P125P P125Q P125R P125S P125T P125U P125V P125W P125X P125Y P125Z P126A P126B P126C P126D P126E P126F P126G P126H P126I P126J P126K P126L P126M P126N P126O P126P P126Q P126R P126S P126T P126U P126V P126W P126X P126Y P126Z P127A P127B P127C P127D P127E P127F P127G P127H P127I P127J P127K P127L P127M P127N P127O P127P P127Q P127R P127S P127T P127U P127V P127W P127X P127Y P127Z P128A P128B P128C P128D P128E P128F P128G P128H P128I P128J P128K P128L P128M P128N P128O P128P P128Q P128R P128S P128T P128U P128V P128W P128X P128Y P128Z P129A P129B P129C P129D P129E P129F P129G P129H P129I P129J P129K P129L P129M P129N P129O P129P P129Q P129R P129S P129T P129U P129V P129W P129X P129Y P129Z P130A P130B P130C P130D P130E P130F P130G P130H P130I P130J P130K P130L P130M P130N P130O P130P P130Q P130R P130S P130T P130U P130V P130W P130X P130Y P130Z P131A P131B P131C P131D P131E P131F P131G P131H P131I P131J P131K P131L P131M P131N P131O P131P P131Q P131R P131S P131T P131U P131V P131W P131X P131Y P131Z P132A P132B P132C P132D P132E P132F P132G P132H P132I P132J P132K P132L P132M P132N P132O P132P P132Q P132R P132S P132T P132U P132V P132W P132X P132Y P132Z P133A P133B P133C P133D P133E P133F P133G P133H P133I P133J P133K P133L P133M P133N P133O P133P P133Q P133R P133S P133T P133U P133V P133W P133X P133Y P133Z P134A P134B P134C P134D P134E P134F P134G P134H P134I P134J P134K P134L P134M P134N P134O P134P P134Q P134R P134S P134T P134U P134V P134W P134X P134Y P134Z P135A P135B P135C P135D P135E P135F P135G P135H P135I P135J P135K P135L P135M P135N P135O P135P P135Q P135R P135S P135T P135U P135V P135W P135X P135Y P135Z P136A P136B P136C P136D P136E P136F P136G P136H P136I P136J P136K P136L P136M P136N P136O P136P P136Q P136R P136S P136T P136U P136V P136W P136X P136Y P136Z P137A P137B P137C P137D P137E P137F P137G P137H P137I P137J P137K P137L P137M P137N P137O P137P P137Q P137R P137S P137T P137U P137V P137W P137X P137Y P137Z P138A P138B P138C P138D P138E P138F P138G P138H P138I P138J P138K P138L P138M P138N P138O P138P P138Q P138R P138S P138T P138U P138V P138W P138X P138Y P138Z P139A P139B P139C P139D P139E P139F P139G P139H P139I P139J P139K P139L P139M P139N P139O P139P P139Q P139R P139S P139T P139U P139V P139W P139X P139Y P139Z P140A P140B P140C P140D P140E P140F P140G P140H P140I P140J P140K P140L P140M P140N P140O P140P P140Q P140R P140S P140T P140U P140V P140W P140X P140Y P140Z P141A P141B P141C P141D P141E P141F P141G P141H P141I P141J P141K P141L P141M P141N P141O P141P P141Q P141R P141S P141T P141U P141V P141W P141X P141Y P141Z P142A P142B P142C P142D P142E P142F P142G P142H P142I P142J P142K P142L P142M P142N P142O P142P P142Q P142R P142S P142T P142U P142V P142W P142X P142Y P142Z P143A P143B P143C P143D P143E P143F P143G P143H P143I P143J P143K P143L P143M P143N P143O P143P P143Q P143R P143S P143T P143U P143V P143W P143X P143Y P143Z P144A P144B P144C P144D P144E P144F P144G P144H P144I P144J P144K P144L P144M P144N P144O P144P P144Q P144R P144S P144T P144U P144V P144W P144X P144Y P144Z P145A P145B P145C P145D P145E P145F P145G P145H P145I P145J P145K P145L P145M P145N P145O P145P P145Q P145R P145S P145T P145U P145V P145W P145X P145Y P145Z P146A P146B P146C P146D P146E P146F P146G P146H P146I P146J P146K P146L P146M P146N P146O P146P P146Q P146R P146S P146T P146U P146V P146W P146X P146Y P146Z P147A P147B P147C P147D P147E P147F P147G P147H P147I P147J P147K P147L P147M P147N P147O P147P P147Q P147R P147S P147T P147U P147V P147W P147X P147Y P147Z P148A P148B P148C P148D P148E P148F P148G P148H P148I P148J P148K P148L P148M P148N P148O P148P P148Q P148R P148S P148T P148U P148V P148W P148X P148Y P148Z P149A P149B P149C P149D P149E P149F P149G P149H P149I P149J P149K P149L P149M P149N P149O P149P P149Q P149R P149S P149T P149U P149V P149W P149X P149Y P149Z P150A P150B P150C P150D P150E P150F P150G P150H P150I P150J P150K P150L P150M P150N P150O P150P P150Q P150R P150S P150T P150U P150V P150W P150X P150Y P150Z P151A P151B P151C P151D P151E P151F P151G P151H P151I P151J P151K P151L P151M P151N P151O P151P P151Q P151R P151S P151T P151U P151V P151W P151X P151Y P151Z P152A P152B P152C P152D P152E P152F P152G P152H P152I P152J P152K P152L P152M P152N P152O P152P P152Q P152R P152S P152T P152U P152V P152W P152X P152Y P152Z P153A P153B P153C P153D P153E P153F P153G P153H P153I P153J P153K P153L P153M P153N P153O P153P P153Q P153R P153S P153T P153U P153V P153W P153X P153Y P153Z P154A P154B P154C P154D P154E P154F P154G P154H P154I P154J P154K P154L P154M P154N P154O P154P P154Q P154R P154S P154T P154U P154V P154W P154X P154Y P154Z P155A P155B P155C P155D P155E P155F P155G P155H P155I P155J P155K P155L P155M P155N P155O P155P P155Q P155R P155S P155T P155U P155V P155W P155X P155Y P155Z P156A P156B P156C P156D P156E P156F P156G P156H P156I P156J P156K P156L P156M P156N P156O P156P P156Q P156R P156S P156T P156U P156V P156W P156X P156Y P156Z P157A P157B P157C P157D P157E P157F P157G P157H P157I P157J P157K P157L P157M P157N P157O P157P P157Q P157R P157S P157T P157U P157V P157W P157X P157Y P157Z P158A P158B P158C P158D P158E P158F P158G P158H P158I P158J P158K P158L P158M P158N P158O P158P P158Q P158R P158S P158T P158U P158V P158W P158X P158Y P158Z P159A P159B P159C P159D P159E P159F P159G P159H P159I P159J P159K P159L P159M P159N P159O P159P P159Q P159R P159S P159T P159U P159V P159W P159X P159Y P159Z P160A P160B P160C P160D P160E P160F P160G P160H P160I P160J P160K P160L P160M P160N P160O P160P P160Q P160R P160S P160T P160U P160V P160W P160X P160Y P160Z P161A P161B P161C P161D P161E P161F P161G P161H P161I P161J P161K P161L P161M P161N P161O P161P P161Q P161R P161S P161T P161U P161V P161W P161X P161Y P161Z P162A P162B P162C P162D P162E P162F P162G P162H P162I P162J P162K P162L P162M P162N P162O P162P P162Q P162R P162S P162T P162U P162V P162W P162X P162Y P162Z P163A P163B P163C P163D P163E P163F P163G P163H P163I P163J P163K P163L P163M P163N P163O P163P P163Q P163R P163S P163T P163U P163V P163W P163X P163Y P163Z P164A P164B P164C P164D P164E P164F P164G P164H P164I P164J P164K P164L P164M P164N P164O P164P P164Q P164R P164S P164T P164U P164V P164W P164X P164Y P164Z P165A P165B P165C P165D P165E P165F P165G P165H P165I P165J P165K P165L P165M P165N P165O P165P P165Q P165R P165S P165T P165U P165V P165W P165X P165Y P165Z P166A P166B P166C P166D P166E P166F P166G P166H P166I P166J P166K P166L P166M P166N P166O P166P P166Q P166R P166S P166T P166U P166V P166W P166X P166Y P166Z P167A P167B P167C P167D P167E P167F P167G P167H P167I P167J P167K P167L P167M P167N P167O P167P P167Q P167R P167S P167T P167U P167V P167W P167X P167Y P167Z P168A P168B P168C P168D P168E P168F P168G P168H P168I P168J P168K P168L P168M P168N P168O P16											

# Appendix III

	MODEL	MODEM/Acoustic COUPLER	SPEED- MIN/MAX	MODULATION SYNCH-ASYNCH	CHANNEL/ CONDITIONING	DUPLEX/SIMPLEX	BUILT-IN EQUALIZATION	MOUNTING/ OEM CARD AVAILABLE	DIMENSIONS (inches)	COPYABLE W/BELL	PRICE	BITS/SECOND /DOLLAR	FEATURES
International Communications Corp. (a Milgo Co.) 7620 N.W. 36th Miami, Fla. 305-836-4550	2230/20 2200/24 3302/36 4502/48 4600/48 4600/72 5500/96 1100	M M M M M M M M	2000/44 1200/2400 2400/3600 4800/48 4800/48 4800/7200 4800/9600 4800/230,400	PM-S PM-S AM/PM-S AM/PM-S AM/PM-S AM/PM-S AM/PM-S 01Phase-S	Voice Voice Voice Voice Voice Voice C1 Voice C2 Special	HD/FD HD/FD HD/FD FD HD/FD C1 FD C2 FD FD	Compro. Compro. Compro. Auto Auto Auto Auto Adj.	Cab, Rack Cab, Ra, Y Cab, Rack Cab, Rack Cab, Rack Cab, Rack Cab, Rack Cab, Rack	3x16x15 3x16x15 8x15x10 5x18x18 6x18x18 6x18x19 6x18x18 3x8x3	201A 201B No No No No No No	\$1780 1780 (53) 3620 (95) 4980 (95) 4750 (85) 6900 (145) 9750 (235) 2300/2800	(53)1.12 (53)1.35 1.0 1.0 1.01 1.04 (235) 17	Uial-up or dedi lines Strap to CCITT 150 Reverse Ch. Com (2) 2400 Ch. Both ends adj from 1 site 4800 Backup UDD, Com (3) 4800 Backup UDD Pair or Coax
	24LSI 20LSI	M M	2400/44 2000/44	PM-S PM-S	Voice Voice	HD/FD HD/FD	Compro. Compro.	Cab, Ra, Y Cab, Ra, Y	3x14x15 3x14x15	201B 201A	1780 (53) 1780 (53)	1.12 1.12	Modem Self Test-LSI Tech. Modem Self Test-LSI Tech.
Intertel, Inc. 6 Vine Brook Pl. Burlington, Mass 617-273-0950	1035E 1038F 1039F 2020C 2021C 2026D 2010B 2011A 2012C	M M M M M M M M M	0/300 0/300 0/300 0/12000 0/1200 0/1820 0/2400 0/2000 0/2400	FM-A FM-A FM-A FM-A FM-A FM-A PM-S PM-S PM-S	Voice Voice Voice Voice Voice Voice Voice Voice Voice	FD FD FD HD HD HD HD/FD HD/FD HD/FD	No No No Compro. Compro. Compro. Compro. Compro.	Yes Yes Yes Yes Yes Yes Yes Yes Yes	6x9 4x9 4x9 4x9 6x9 4x9 9x13 9x13 9x13	103A/E 103F 103F 20209 202C10 2020 2018 201A 2018	\$480 350 350 500 600 500 1325 1325 1325	\$ 1.4 1.4 3.7 2.7 5.8 2.3 2.1 2.1	
Livermore Data Systems 2050 Research Dr. Livermore, Ca. 415-447-2252	B 716 71C 71E 71F 71H 71J	A A A DAA DAA A/DAA A/DAA	0/300 0/300 0/300 0/300 0/300 0/300 0/300	FM-A FM-A FM-A FM-A FM-A FM-A FM-A	Voice Voice Voice Voice Voice Voice Voice	HD/FD HD/FD HD/FD HD/FD HD/FD HD/FD HD/FD	No No No No No No No	Cab, Yes Cab, Yes Cab, Yes Cab, Yes Cab, Yes Cab, Yes Cab, Yes	10x4x4x8x4 11x8x6 11x8x4 11x6x4x4 11x6x4x4 11x6x4x4 11x6x4x4	103/1135250 103/113 360 103/113 235 103/113 325 103/113 350 103/113 325 103/113 350	\$1.2 .84 1.28 .92 1.04 .86 .92	Walnut Case Walnut Case Plastic Case Plastic Case " " " "	
Magnox Re- Search Labs Torrance, Ca.	HX180 HX170B	M M	to 19 mil. 1700,2400										Very HI Speed for Satellite channels
M12 Data Systems Inc. Design Elements, Division 1356 Norton Ave. Columbus, Ohio	76-1 88 101DN 103 103CTH 1200	A A/H M M M A	0/300 0/300 0/300 0/300 0/300 0/1200	FM-A FM-A FM-A FM-A FM-A FM-A	Voice Voice Voice Voice Voice Voice	FD/HD FD/HD FD/HD FD/HD FD/HD FD/150	No No No No No Yes	Desk, Yes Cab, Yes Cab, Yes Cab, Yes Desk, Cab Desk, Yes	11x7x4 11x8x4 14x8x2-5/8 12x7x5 11x7x4	101/103/113 113 113 202			Auto. Ans., DAA opts. Fits in Teletype Orig/Auto Ans. Orig/Auto Ans. Desk top version of 103 Inc. 150 & 10 b rev. ch.
Mat' Midco Ind. Trenton, N.J.	ADC-300	A/H	0/300	FM-A	Voice	HD/FD/S	No	Cab, Yes	6x8x6 cd4x5x5	103 ser.	\$ 129-\$ 80- 340 2.2		Ans. send, configur.
Novation 18664 Tophan St. Bartons, Co. 213-344-7191	TH-OC EC-100A, AD ATL-ADM 202 201	A/H A/H M M M	0/440 0/450 0/450 0/1800 2000/2400	FM-A FM-A FM-A FM-A DPSK	Voice Voice Voice Voice Voice	HD/FD FD HD/FD HD/AD C2 HD/AD	No No No Yes Yes	Cab, b/c In yes Card Cab, Yes Cab/Card Cab/Card	OC11x11x3 4x10 2x7x10 6x10x2 12x15x3	103 103 103 202 201A/B	\$ 315 C100 520 366 1200	.85- 350 .95 4.4 2.0 2.9	Ans. send, configur. Teletype built in Custom MOS
QXI-Elec. Ind. 875 Ave. of Amer. New York, N.Y. 212-868-9540/1	BH1655 BH1666 BH1658 BH1392	M M M M	0/200 0/200 0/1200 2400	FM-A FM-A FM-A PM-S	Voice Voice Voice Voice	HD/FD HD/FD HD/FD/4W HD/FD	No No Compro. Compro.	Cab Cab Cab Cab	7x11x16 7x11x16 7x11x16 7x11x16	770 890 940 2000	\$ 770 890 940 2000	.26 .22 1.28 1.2	
Omnic (A Hytronics Corp.) Phoenix, Ariz.	7018 701C 701D 702A 703A 750 4000	A/H A/H A/H A/H A/H A/H N/A	0/450 0/150 0/300 0/300 0/300 0/300 0/600	FM-A FM-A FM-A FM-A FM-A FM-A A	Voice Voice Voice Voice Voice Voice N/A	HD/FD HD/FD HD/FD HD/FD HD/FD HD/FD FD	No No No No No No No	Cab Built in Built in Cab Cab Cab Cab, b/c	6x6x12 6x3x11 8x4x11 8x4x11 8x4x11 6x4x11 11x4x8x4	103A2 103A2 103A 103A 103A 103A 103A	310 245 295 365 445 335 130-465		
Paradyne Corp. 8550 Ulmerton Largo, Fla. 813-436-4771	H-48 PTX-600 BTST-HC-48 HARD-48	M M M M	4800/4800 4800/4800 4800/4800 4800/4800	AM-S AM-S AM-S AM-S	Voice Voice Voice Voice	HD/FD HD/FD HD/FD HD/FD	Auto Adapt. " " "	Cab, Rack Cab, Rack Cab, Rack Cab, Rack	8x17x19 8x17x19 8x17x19 8x17x19	No No No No	\$4250 6450 6450 5950	\$1.13 .75 .75 .8	Vo Adp Prov Vo Parallel Adapter Built in error Cont.
Panfil Data Communications Inc. 5520 Randolph Rockville, Md. 301-881-8151	PDC330A2 T117-300 PDC-311A PDC-313B PDC-311C PDC-313D PDC-300E PDC-3131 PDC-3137 PDC-300F PDC-1200/S PDC-1200/150 PDC-1800B PDC-1800S PDC-2400B PDC-2400C PDC-2400E PDC-1800A PDC-4800D PDC-4800E PDC-4800F QAM-1300	M M	0/300 0/300 0/300 0/300 0/300 0/300 0/300 0/300 0/300 0/300 0/1200 0/1200/150 0/1800 1800 2400 2400 1200/2400 2400/4800 2400/4800 2400/4800 2400/4800 0/1300	FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-A FM-S PM-S PM-S QAM-S QAM-S QAM-S QAM-S 8 Phase S	No No	HD/FD HD/FD HD/FD HD/FD HD HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO HD/TO	No No	Cab, Ra, Y Teletype cd Cab, Ra, T Cab, Ra, Y Cab Cab, Ra, Y "	2cds4x4 4x1x6 4x10x10 4x4x7 " 				

Continued on next page

# Appendix III

Tuck Electronics 235 Market St. New Cumberland, Pa. 17070 717-232-4331	1033	M	0/300	FM-A	Voice	FD/HD	No			103		Up to 40 Rack
	1033A	M	0/300	FM-A	Voice	FD/HD	No			103		Auto Ans
	1033AP	M	0/300	FM-A	Voice	FD/HD	No			103		Ans Only
	1042F	M	0/300	FM-A	Voice	FD/HD	No			103		Orig Only
	1042F1	A	0/300	FM-A	Voice	FD/HD	No			103		Ans Only
	1042AP	M	0/300	FM-A	Voice	FD/HD	No			103		Ans Only
	1042HD	A	0/300	FM-A	Voice	FD/HD	No			103		Ans Only
	1047	A	0/300	FM-A	Voice	FD/HD	No			103		Man Dial
	1047AA	M	0/300	FM-A	Voice	FD/HD	No			103		TTP Inter 103A2/103E2
	1047AP	M	0/300	FM-A	Voice	FD/HD	No			103		Auto Ans Priv Ket
	1075	M	0/300	FM-A	Voice	FD/HD	No			103		Up to 40/Rack
	1075AA	M	0/300	FM-A	Voice	FD/HD	No			103		Auto Ans/Orig
	1075AP	M	0/300	FM-A	Voice	FD/HD	No			103		Up to 40/Rack
	1167/0	A	0/300	FM-A	Voice	FD/HD	No			103		ODM-TT1 Logic
	1176	A	0/300	FM-A	Voice	FD/HD	No			103		Special Interface
Tycos Sys. Corp. Pompton Lakes, NJ 201-839-3000	900	A/H	0/300	FM-A	Voice	FD/HD	No	Card, Yes 4x9	103A2 103E/F	Cd. 69 cov. 90	4.35	103 Orig Only
	Mark V	A	110/300	FM-A	Voice	FD/HD	No	Cab, No 11 1/2x8 1/2x4 1/2	103A	475	.63	
	Mark XV	M	0/300	FM-A	Voice	FD/HD	No	Cab, No 16x11 1/2	103			
	8543	M	0/9600	DC-A/S	Private	FD/HD		Cab	10x4 1/2x7 1/2	No	600	Short Dist-pt-to-pt
	UDS-103	M	0/300	FM-A	Voice	FD	No	Cab, Ra, Y 3 1/2x8x10	103	395	.76	
	UDS-20255	M	0/1800	FM-A	Vo-1200	HD/FFD	Comp	3ca 6x4 1/2	202	365-560	4.9	
	UDS-202H5	M	0/1800	FM-A	Vo-1200	HD/FFD	Comp	3 1/2x8x10	202	675	2.68	
	UDS-202	M	0/1800	FM-A	Vo-1200	HD/FFD	Comp	3 1/2x8x10	202	250-445	7.2	
	90	A/H	0/300	FM-A	Voice	FD/HD	No	Cab, Yes 4x4x10	103	350	.86	Orig Only
	91	A/H	0/300	FM-A	Voice	FD/HD	No	Cab, Yes 4x4x10	103	415	.72	Ans/Orig
	92	A/H	0/300	FM-A	Voice	FD/HD	No	PC-Board		120	2.5	18M LDLA Comp.
	VA21	M	0/300	FM-A	Voice	FD	No	Cab, Ra, Y PC-455		350-450	.86	Comp W CCITT-Y-21&24
	51VA23	M	0/1200	FM-A	Voice	FD/HD	Yes	Cab, Ra, Y PC-855g. In		350-500	3.4	Op*75b R Ch-CCITT-V23, 24
	VA1200	M	0/1800	FM-A	Vo-1200 C2-1800	FD/HD	Yes	Cab, Ra, Y 202CDE		250-300	7.2	Op*501506 Rev. Ch
Western Union 82 McKee Dr. Mahwah, N.J. 201-529-4600	1601B	M	0/600	FM-A	Voice			5x11x9				
	2221B	M	0/1200	FM-A	Voice			5x11x9				
	2247A	M	2400	PM-S		FD/HD		7x19x18				
	2401A	M	4800	PM-S		FD/HD		8x18x18 5/8				
	2200/24	M	1200/2400	PM-S		FD/HD		3x16 3/4x15 5/8				